NAME (Block Print)____

CHEMISTRY 102 FALL 2010

FINAL EXAM FORM D Section 502 DR. KEENEY-KENNICUTT

Directions: (1) Put your name on PART 1 and your name and signature on PART 2 of the exam where indicated.
(2) Sign the Aggie Code on PART 2 of this exam.
(3) Each multiple choice question is actually 2 questions on your scanning sheet. If you are sure of an answer, **put the same answer down for both questions** for 5 pts. If you cannot decide between two answers, put your best answer down for the first (odd) question and the other answer down for the second (even) question. If you get the first one correct you'll get 3 pts; if you get the second one correct you'll get 2 pts. If there is an ambiguous multiple choice question, use the last page to explain your answer.
(4) Do NOT write on the envelope.
(5) When finished, put everything in the envelope and wait to be excused. At the table, take everything out of the envelope. You can pick up the multiple choice part with the answers outside my office after the exam.
(6) There are a total of 60 multiple choice questions (30 actual questions) plus 20 pts free response.

PART 1

1&2. Which one of the following combinations **cannot** produce a buffer solution?

(a) HNO_2 and $NaNO_2$ (b) NH_3 and $(NH_4)_2SO_4$ (c) $HClO_4$ and $NaClO_4$
(d) NH_3 and NH_4Br (e) HCN and NaCN

3&4. The rate law for the chemical reaction, $2ClO_2(aq) + 2OH^-(aq) \rightarrow ClO_3^-(aq) + ClO_2^-(aq) + H_2O(\ell)$ has been determined experimentally to be: Rate = $k[ClO_2]^2[OH^-]$
The reaction order with respect to the hydroxide ions is:

(a) 3 (b) 2 (c) 1 (d) $k[OH^-]^2$ (e) $k[ClO_2]^2[OH^-]$

5&6. Which is the correct K_c expression for the equilibrium: $2C(s) + O_2(g) \rightleftarrows 2CO(g)$?

(a) $K_c = \frac{2[CO]}{2[C][O_2]}$ (b) $K_c = \frac{[C]^2[O_2]}{[CO]^2}$ (c) $K_c = \frac{[CO]^2}{[C]^2[O_2]}$

(d) $K_c = \frac{[CO]^2}{[O_2]}$ (e) $K_c = \frac{[O_2]}{[CO]^2}$

7&8. Which of the following statements is **FALSE**?

(a) ΔS is a state function.
(b) A reaction is spontaneous if $\Delta S_{universe}$ decreases.
(c) Endothermic processes are those that absorb heat.
(d) At absolute 0 K, the entropy of a pure perfect crystalline substance is zero.
(e) The system's enthalpy alone does not determine the spontaneity of a reaction.

9&10. The best representation for the reaction whose heat of reaction is equal to the standard molar enthalpy of formation for $HNO_3(g)$ is:

(a) $H(g) + N(g) + 3O(g) \rightarrow HNO_3(g)$

(b) $HNO_3(g) \rightarrow ½ H_2(g) + ½ N_2(g) + 3/2 O_2(g)$

(c) $2HNO_3(g) \rightarrow H_2(g) + N_2(g) + 3 O_2(g)$

(d) $H_2(g) + N_2(g) + 3 O_2(g) \rightarrow 2HNO_3(g)$

(e) $½ H_2(g) + ½ N_2(g) + 3/2 O_2(g) \rightarrow HNO_3(g)$

11&12. Which statement is **TRUE** about aqueous solutions?

(a) As the value of the van't Hoff factor of the solute increases, the freezing point of the solution will increase.

(b) A solution can only be made by dissolving a solid into a liquid.

(c) When the molality of the solute doubles, the boiling point of the solution will double.

(d) When a solute dissolves into the solvent, the vapor pressure of the solution will be lower than the vapor pressure of the pure solvent at a particular temperature.

(e) A solution is a heterogeneous mixture in which no settling occurs.

13&14. Which of the following species is the STRONGEST oxidizing agent?

(a) Co^{2+} (b) Zn^{2+} (c) Cr^{2+} (d) Cu (e) Cr

15&16. Consider the following gaseous phase system at equilibrium:

$$I_2(g) + Cl_2(g) \rightleftarrows 2ICl(g) \qquad \Delta H = -27 \text{ kJ}$$

Which of the following changes will DECREASE the amount of ICl at equilibrium?

(a) adding N_2 (*g*)
(b) adding a catalyst
(c) decreasing the volume of the container
(d) adding I_2 (*g*)
(e) raising the temperature

17&18. Consider the following gas phase reaction: $A + 2B \rightarrow AB_2$, which occurs by the following mechanism:

Step 1	$A + B \rightarrow AB$	slow
Step 2	$AB + B \rightarrow AB_2$	fast
Overall	$A + 2B \rightarrow AB_2$	

The rate law expression must be Rate = ________.

(a) k[A][B] (b) k[B] (c) $k[A][B]^2$ (d) $k[B]^2$ (e) k[A]

19&20. The relationship between K_{sp} and s, the molar solubility in mol/L, for PbI_2 is:

(a) $K_{sp} = 4s^2$ (b) $K_{sp} = 4s^3$ (c) $K_{sp} = s^{1/3}$
(d) $K_{sp} = s^2$ (e) $K_{sp} = s^3$

21&22. Consider the following reaction and choose the correct statement:

$$H_2(g) + Br_2(\ell) \rightarrow 2\,HBr(g) \qquad \Delta H^o = -72.8 \text{ kJ}, \quad \Delta S^o = +114 \text{ J/K}$$

(a) The reaction becomes spontaneous as the temperature increases.
(b) The reaction becomes nonspontaneous as the temperature increases.
(c) The reaction is nonspontaneous at all temperatures.
(d) The reaction is spontaneous at all temperatures.
(e) The temperature does not influence the spontaneity of any reaction.

23&24. Which of the following statements is **FALSE** about solubility and miscibility?

(a) Iodine, $I_2(s)$, should be more soluble in water than in carbon tetrachloride, CCl_4,
(b) Benzene, C_6H_6, is miscible in chloroform, $CHCl_3$.
(c) In the phrase "Like dissolves like," the term "like" refers to molecules with similar polarities.
(d) Water and ethanol, CH_3CH_2OH are miscible.
(e) KCl is more soluble in water than BaS.

25&26. Which one of the following statements is TRUE about the following reaction?

$$CH_3NH_2 + H_2O \rightleftarrows CH_3NH_3^+ + OH^-$$

(a) OH^- is the conjugate acid of H_2O.
(b) H_2O is the conjugate base of OH^-.
(c) CH_3NH_2 is the conjugate base of H_2O.
(d) $CH_3NH_3^+$ is the conjugate acid of CH_3NH_2.
(e) There are no conjugate acid-base pairs.

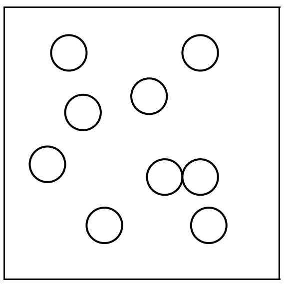
27&28. Which statement or statements is/are TRUE about the purpose of a catalyst?
(1) Catalysts increase the number of collisions between the reactants in the overall reaction.
(2) A catalyst cannot appear as a reactant in a rate law expression.
(3) A catalyst lowers the activation energy of both the forward and reverse reaction.

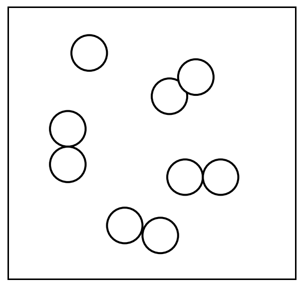
(a) 1 & 2 (b) 2 & 3 (c) 1 & 3 (d) only 1 (e) only 3

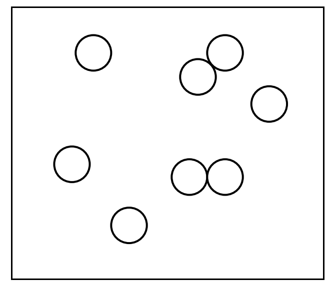
29&30. During the electrolysis of aqueous KBr solution using inert electrodes, bromine liquid is evolved at one electrode and hydrogen gas is evolved at the other electrode. The solution around the electrode at which hydrogen gas is evolved becomes basic as the electrolysis proceeds. Which of the following is FALSE?

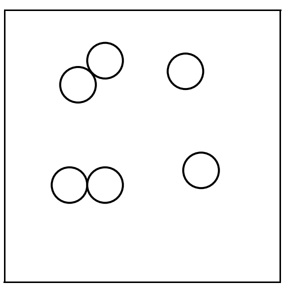
(a) The electrode where the hydrogen gas is evolved is positively charged.
(b) Faraday's Law says that the longer the cell runs, the more $H_2(g)$ will be produced.
(c) The electrons flow out of the battery into the negatively charged electrode.
(d) The bromide concentration in the cell will decrease.
(e) The electrode where bromine liquid is evolved is the anode.

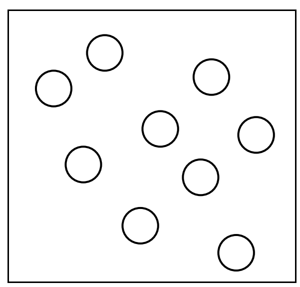
31&32. Consider the equilibrium, $2A \rightleftarrows A_2$ with Kc >> 1. Which picture represents this system?

(a)


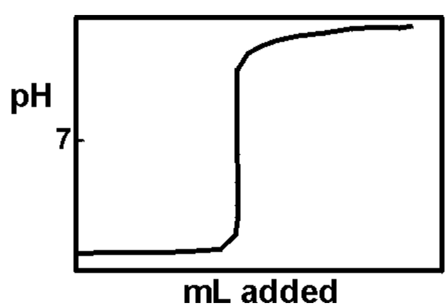
(b)


(c)


(d)


(e)


33&34. In this titration, what is being titrated with what?



(a) a strong acid is being titrated with a strong base
(b) a strong base is being titrated with a strong acid
(c) a weak acid is being titrated with a strong base
(d) a weak base is being titrated with a strong acid
(e) none of the above.

35&36. What is the pH of a 1.5×10^{-4} M KOH?

(a) 2.95 (b) 3.80 (c) 10.18 (d) 10.79 (e) 11.52

37&38. What is the pH of a 0.70 M formic acid solution?

(a) 4.19 (b) 3.27 (c) 2.32 (d) 4.85 (e) 1.95

39&40. Rate data were collected for the following reaction at a particular temperature. What is the correct rate law expression?

$$A + 2B \rightarrow C + 3D$$

Experiment	$[A]_{initial}$	$[B]_{initial}$	Initial Rate of Reaction
1	0.10 M	0.40 M	0.0090 M/min
2	0.20 M	0.40 M	0.036 M/min
3	0.10 M	0.20 M	0.0045 M/min

(a) Rate = k[A][B] (b) Rate = $k[A]^2[B]$ (c) Rate = $k[A][B]^2$
(d) Rate = $k[A]^2[B]^2$ (e) Rate = $k[A]^2$

41&42. If a solution is 1.0×10^{-2} M in Mg^{2+} and 1.0×10^{-4} M in F^-, will precipitation occur?

(a) No, because Qsp < Ksp
(b) No, because Ksp < Qsp
(c) Yes, because Qsp < Ksp
(d) Yes, because Ksp < Qsp
(e) cannot be determined

43&44. Calculate the standard cell potential for the cell: $Fe/FeSO_4$ (1 M) || $CuSO_4$ (1 M) /Cu

(a) +0.65 V (b) +0.15 V (c) +0.06 V (d) +0.32 V (e) +0.78 V

45&46. If 4.27 grams of sucrose, $C_{12}H_{22}O_{11}$ are dissolved in 16.2 grams of water, what will be the boiling point of the resulting solution?

(a) 101.64°C (b) 100.39°C (c) 99.626°C (d) 100.73°C (e) 101.42°C

47&48. How many grams of chromium metal can be made from a solution of $Cr(NO_3)_3$ when a current of 4.00 amperes flows for 50.0 minutes?

(a) 3.68 g (b) 1.43 g (c) 2.16 g (d) 0.824 g (e) 1.63 g

49&50. What is the enthalpy change of the reaction below at 298 K and 1 atm pressure?

	$SiH_4(s)$	+	$2O_2(g)$	$\rightarrow$	$SiO_2(s)$	+	$2H_2O(g)$
$\Delta H^{o}_{f\,298}$ (kJ/mol)	+34		0		–910.9		–285.8

(a) –1159 kJ
(b) –955 kJ
(c) –1230 kJ
(d) –1250 kJ
(e) –1517 kJ

51&52. What concentration of Pb^{2+} will initiate precipitation in a solution that is 0.010 M NaBr?

(a) 6.3×10^{-1} M
(b) 6.3×10^{-4} M
(c) 6.3×10^{-6} M
(d) 6.3×10^{-2} M
(e) 6.3×10^{-5} M

53&54. What ratio of [HNO_2]/[NO_2^-] is required to give a solution with a pH of 4.00?

(a) 4.6:1 (b) 0.22:1 (c) 1:1 (d) 2.7:1 (e) 0.15:1

55&56. Calculate the pH of a 0.25 M NaBrO solution.

(a) 11.00 (b) 9.69 (c) 8.50 (d) 9.46 (e) 10.12

OVER ⇒

57&58. Consider the following equilibrium reaction: $N_2(g) + O_2(g) \rightleftarrows 2NO(g)$ $K_c = 4.0 \times 10^{-4}$ at 2010 K

If the initial concentration of NO in a closed container is 3.00 M, what will be the concentration of NO after the system finally reaches equilibrium at 2010 K?

(a) 0.49 M (b) 0.10 M (c) 0.007 M (d) 0.030 M (e) 1.30 M

59&60. Consider the reaction: $2\,CO(g) \rightarrow C\text{ (s, graphite)} + CO_2(g) \underline{+\ 172.5\text{ kJ}}$

At 25°C, the ΔS^o for the reaction is –175.9 J/K. Calculate ΔG^o for the reaction at 25°C.

(a) –178 kJ (b) –197 kJ (c) –120. kJ (d) 0.981 kJ (e) 4620 kJ

CHEMISTRY 102 **FALL 2010** NAME ____________________

FINAL EXAM Section 502 (Please blockprint)

Form D

PART 2

Please read and sign: "On my honor, as an Aggie, I have neither given nor received unauthorized aid on this exam." ______________________________

(5 pts) **61.** Calculate the potential (in volts) for the non-standard voltaic cell when the following two half-cells are connected: Anode: Ag electrode in 1.0×10^{-3} Ag^{+} solution
Cathode: Au electrode in 0.10 M Au^{3+} solution

Given: $E_{cell} = E^{o}_{cell} - (0.0257/n) \bullet \ln Q_{thermo}$ $\quad\quad$ $E_{cell} = E^{o}_{cell} - (0.0592/n) \bullet \log Q_{thermo}$

(5 pts) **62.** Assign oxidation numbers to every element in the reaction (2 pts). Balance the following redox reaction in acidic solution (3 pts):

$$Cu + NO_3^- \rightarrow Cu^{2+} + NO$$

OVER ⇒

(5 pts) **63.** A buffer is prepared by mixing 100 mL of 0.200 M ammonia and 300 mL of 0.100 M ammonium chloride. What is the pH of the final solution after 20.0 mL of 0.400 M HCl is added?

64. Draw the voltaic cell that results when the following 2 half cells are connected:

(1) an iron electrode is put into a solution of 1.00 M Fe^{2+} solution and

(2) a lead electrode is put into a solution of 1.00 M Pb^{2+} solution.

Observations:

(1) The iron electrode decreases in mass while the $[Fe^{2+}]$ increases

(2) The lead electrode increases in mass while the $[Pb^{2+}]$ decreases

(1 pt) Label the anode and give the anodic reaction.

(1 pt) Label the cathode and give the cathodic reaction?

(1 pt) Give the sign on each electrode?

(1 pt) Show the direction of the electron flow.

(1 pt) What is the overall reaction?

SCRAP PAPER OR COMMENTS ON THIS EXAM